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A new species of *Hadrocryptus* (Hymenoptera, Ichneumonidae, Cryptinae), with the first account of the biology for the genus

Christophe Barthélémy[1,†], Gavin R. Broad[2,‡]

1 *Sai Kung Country Park, Hong Kong* **2** *Department of Entomology, The Natural History Museum, London*

† *urn:lsid:zoobank.org:author:463D39B1-C65C-4DBD-AC9E-3C9F37878D76*
‡ *urn:lsid:zoobank.org:author:D06689DE-526F-4CFA-8BEB-9FB38850754A*

Corresponding author: *Gavin R. Broad* (g.broad@nhm.ac.uk)

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Abstract

A new species of the cryptine genus *Hadrocryptus* is described based on specimens reared from bamboo trap nests in Hong Kong. *Hadrocryptus perforator* sp. n. is an ectoparasitoid of aculeate Hymenoptera larvae and prepupae of the families Vespidae (Eumeninae) and Sphecidae. These are the first host records for this genus.

Keywords

Xenorhynchium, *Zethus*, *Isodontia diodon*, taxonomy, host, Sphecinae

Introduction

The subfamily Cryptinae is the largest subfamily of Ichneumonidae, with about 400 genera described to date (Yu et al. 2005; subsequent publications) and species of cryptine may be encountered commonly throughout much of the world. Where known, most species are idiobiont ectoparasitoids of prepupae or pupae of holometabolous in-

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sects enclosed in cocoons or plant tissues, although the vast majority of species remain unknown biologically. Although individual species tend to have restricted host ranges (Schwarz and Shaw 1998), known hosts across the subfamily are varied and include members of Lepidoptera, Coleoptera, Diptera, Neuroptera, Raphidioptera and Hymenoptera as well as egg sacs of some Pseudoscorpionida and Araneae.

Hadrocryptus Cameron, 1903 belongs to a group of genera in the tribe Cryptini that are often referred to as the sub-tribe Gabuniina. Where known, gabuniines parasitise wood-boring beetles (Townes and Townes 1962), however there are no host records for most of the genera, including *Hadrocryptus* previously. Here we report on the biology of *Hadrocryptus perforator* sp. n. as a parasitoid of a common eumenine in Hong Kong, *Xenorhynchium* sp., and as an occasional parasitoid of another eumenine, *Zethus* sp., and a sphecid, *Isodontia diodon* (Kohl), in trap nests.

There are six described species of *Hadrocryptus*, found in India, Bhutan, the Philippines, Indonesia and Malaysia (Gupta and Gupta 1983); however, the species that was reared in Hong Kong represents an undescribed taxon.

Taxonomy

Morphological terminology follows Gauld (1991) but the species description is modelled on those provided by Gupta and Gupta (1983), who provide a key to the species of *Hadrocryptus* then known. Images of pinned specimens were taken with a Canon EOS 450D digital camera attached to a Leica MZ 16 stereomicroscope. Several partially focused images were combined using Helicon Focus v. 4.80 software. Trap nest content pictures were taken at various stages of the host and parasitoid development with a Nikon D200 equipped with a Nikorr 60mm macro lens and Sunpak R12 ring flash, a stainless steel ruler was placed in the frame to determine scale at editing. Pictures were edited using Nikon Capture NX and Adobe Photoshop CS2 softwares. Collection acronyms: BMNH – Natural History Museum, London; BPC – Barthélémy, private collection.

Recognition of Hadrocryptus

Apical flagellomere with truncate hammer. Face with horn just below and between antennal sockets. Clypeus with median tooth. Mandible with lower tooth longer than upper. Epomia short and weak. Mesoscutum short, slightly wider than long and no longer than area of propodeum behind anterior transverse carina. Groove between metapleurum and propodeum wide, crossed by carinae. Propodeum lacking pleural carina between anterior transverse carina and hind coxa. Propodeal spiracle elongate. Fore tibia swollen. First tergite with pronounced basal, lateral teeth; with elongate, dorsal depression at level of spiracles. Second tergite strongly punctate. Ovipositor lower valve with vertical teeth, dorsal lobe enclosing upper valve. Fore wing vein *cu-a* far basal to *Rs+M*. Hind wing with abscissa of *Cu* between *M* and *cu-a* longer than *cu-a*.

***Hadrocryptus perforator* Broad & Barthélémy, sp. n.**
urn:lsid:zoobank.org:act:42AA95D5-15E8-40F5-913C-8A813439968E
http://species-id.net/wiki/Hadrocryptus_perforator

Holotype. Female, exact label data: 'Pak Sha O, HK 50Q KK 242 849. 70m C. Barthélémy, 22.iii.10 Ref: 0386.A.Hy.1', 'Hong Kong Ex *Xenorhynchium* sp. in bamboo trap nest, coll. 7.2009, em. 3.2010 BMNH(E) 2010-74 AQ', BMNH. Paratypes: 1 female, same data as holotype but '20.iii.10 Ref: 0384.A.Hy.1', 1 male, same data as holotype but '13.vi.10 Ref: 0414.A.Hy.1' and 'Ex *Isodontia diodon* in bamboo nest em. 6.2010', both BMNH; 1 female same data as holotype, 1 female same data as holotype but '20.iii.10, ref.: 0383.A.Hy.1', 2 males same data as holotype but ' 03.iv.11 ref.: 0432.A.Hy.1' and ' Ex. *Zethus* sp.', all BPC.

Female. First flagellomere 7.0× as long as apically wide (basal 'annellus' section excluded). Frons largely polished, with weak punctures ventral to ocelli and some oblique wrinkling in a V-shape ventral to anterior ocellus. Vertex with conspicuous punctures, separated by more than twice their diameter. Facial horn, just below and between antennal sockets, large, pointed oval in dorsal view, protruding by distance slightly greater than inter-antennal distance (Fig. 1a). Face and clypeus closely punctate, punctures becoming confluent medially on face. Clypeus apically concave with obtuse, low median tooth.

Pronotum mostly smooth, transversely striate lateromedially with short transverse striae along posterior edge. Mesoscutum polished, weakly granulate anteriorly, with isolated punctures anteriorly, medially. Notauli strong to level of anterior edge of notauli, fading then. Scutellum with punctures on smooth background, separated by about their own diameter. Mesopleuron densely punctate, punctures small and separated by about their diameter, except transversely striate anterodorsally and medially, speculum and subalar prominence weakly punctate on smooth background. Metapleuron strongly punctate posterodorsally, sparsely punctate medially. Pleural carina absent except basally. Juxtacoxal carina strong but with narrow interruptions anteriorly and posteriorly. Submetapleural carina complete. Propodeum with area anterior of anterior transverse carina polished, punctate in posterior half; anterior transverse carina strong, complete; remainder of dorsal surface reticulate, transversely striate medially (Fig. 1c). First tergite polished, punctate on apical half, punctures coalescing medially, apically (Fig. 1c). Lower edge of first sternite with weak teeth, separated by more than their width. Second tergite with semicircular basal, median area defined by depression behind this; third tergite with basal area defined by shallower curve; second and third tergites densely punctate, punctures faint on successive tergites. Ovipositor (measured from tip of hypopygium) 2.1× length of hind tibia.

Mainly black with copious ivory/white markings (Fig. 1b). The following ivory: several median flagellomeres, face, clypeus (except for small basal, median black patch), horn on upper face, inner orbits to vertex, outer orbits to dorsal 0.7 of eye, central, median part of pronotum, lateral corners of median lobe of mesoscutum, central area on mesoscutum, tegula, short section of lateral carina of mesoscutum immediately anterior

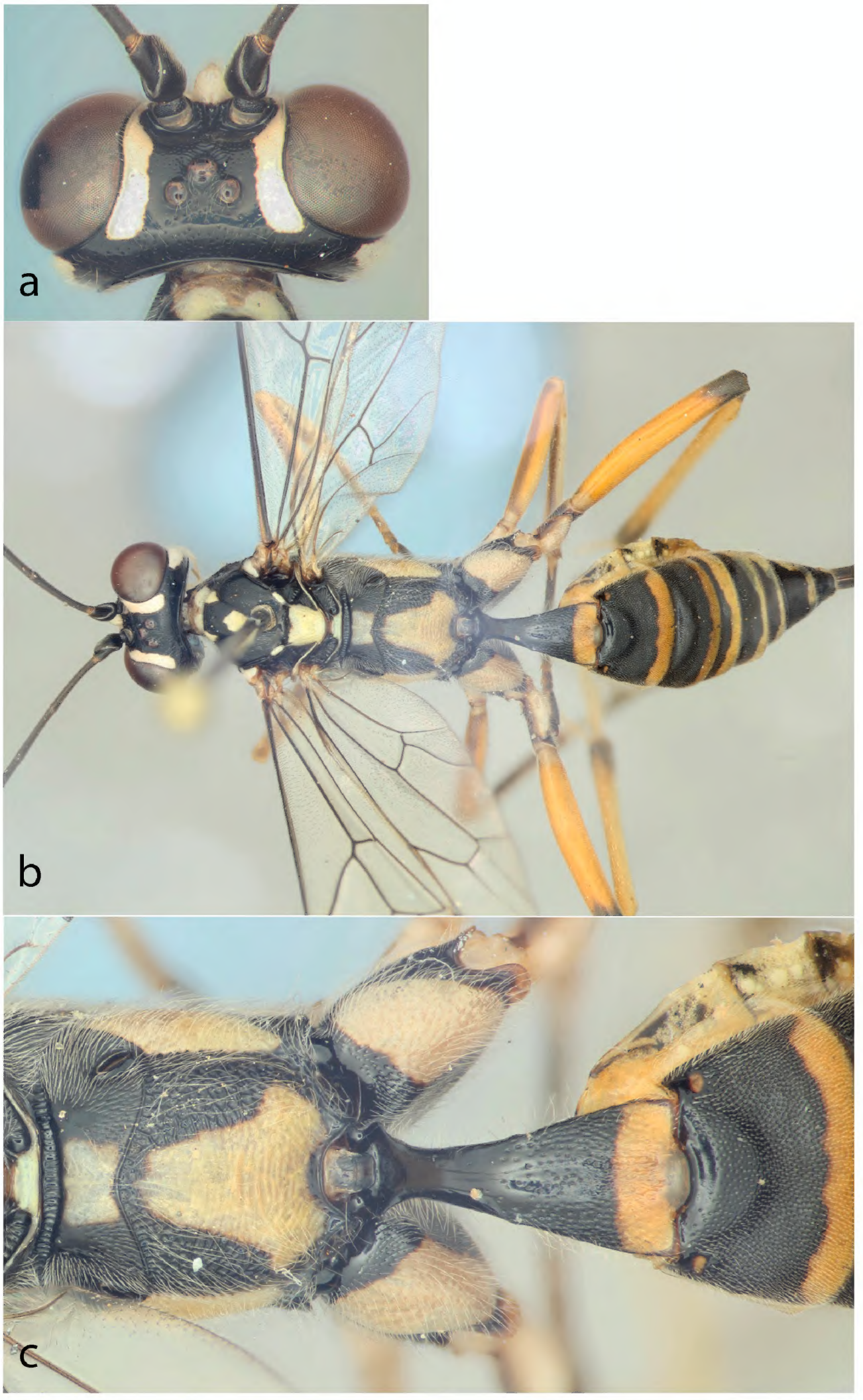

Figure 1. Holotype female of *Hadrocryptus perforator* sp. n.; **a** head, dorsal view, showing horn; **b** whole body, dorsal view; **c** propodeum and base of metasoma, dorsal view.

to scuto-scutellar groove, subalar prominence, posteroventral patch on mesopleurum, scutellum, metascutellum, median longitudinal stripe on propodeum, interrupted posterior to transverse carina, widened posteriorly, metapleurum dorsally, posteriorly, fore and mid coxae (except tiny lateral black spot), extensive dorsal, posterior area on hind coxa, all trochanters (with brown dorsal stripe on mid and hind trochanters), fore and mid trochantelli, ventral patch on hind trochantellus, outer surface of fore and mid tarsomeres 1 to 3, all of hind tarsus except for apical patch on 5th, posterior bands on 1st to 7th tergites dull yellow or cream. Fore and mid femora and tibiae orange with dark brown dorsal stripes, fading to cream ventrally, hind tibia orange, apical 0.18 black, hind femur orange, apically and basally black-ringed.

Male. Similar to female, differs (in addition to the obvious sexual differences) only in the more extensive ivory area on the mesopleuron, extending anteriorly as lateral and median stripes on the mesosternum, and in the less modified antenna tip (simply pointed).

Remarks. *Hadrocryptus* is an easily recognised genus of the *Gabunia* genus-group (Gabuniina of Townes 1970), with its prominent facial tubercle in combination with several other characters (e.g. lateral, basal teeth on the first tergite, absence of the pleural carina). Gupta and Gupta (1983) revised the species of *Hadrocryptus*, which are restricted to the Oriental region. In Gupta and Gupta's key, *Hadrocryptus perforator* sp. nov. will key out to *H. ditissimus* (Tosquinet), from which it differs most obviously in the much weaker ventral teeth on the first sternite and the centrally white pronotal collar.

Biology of *Hadrocryptus perforator*

Materials and methods

Hadrocryptus perforator was reared from six trap nests placed in and collected from three locations in Hong Kong: (1) Ng Tung Chai, UTM 50Q KK 042 840, 140m asl, trap referenced as NTC-028.A4, set adjacent to a healthy 60+ year old forest on the slopes of Hong Kong's highest peak; (2) Sha Lo Tong, UTM 50Q KK 100 886, 180m asl, trap referenced as SLT-025.A1 and SLT-025.A4 of the same bundle, set adjacent to a Fung Shui wood behind an abandoned village; and (3) Pak Sha O, UTM 50Q KK 242 849, 70m asl, trap referenced as PSO-093.A3, PSO-117.A2 and PSO-117.A6 set in the first author's garden adjacent to a healthy secondary growth forest. All locations were in shaded environments.

The traps consisted of hollow bamboo canes of varied length and diameter that were cut so that one end was closed by a nodal septum. Clusters of four to seven cut canes were bundled together and hung from low branches on various bushes and trees. Dimensions of traps are given in Table 1

Upon collection, segments were placed in Ziploc® bags and opened in the laboratory for content examination, the data are summarised in Table 2.

Table 1. Trap physical dimensions and dates of Collection.

Trap reference	Date set	Date collected	Trap diameter (mm)	Trap length (mm)
SLT.025.A1	17-Apr-09	22-Feb-10	10	250
SLT.025.A4	17-Apr-09	22-Feb-10	10.5	253
NTC.028.A4	17-Apr-09	10-Jul-09	11	250
PSO-093.A3	12-Apr-10	03-Jun-10	7.5	165
PSO-117.A2	23-Jun-10	26-Sep-10	9	225
PSO-117.A6	23-Jun-10	31-Oct-10	8	225

Observations & Discussion

At opening on 10 July 2009, trap NTC-028.A4 contained a single cell with a prepupal larva of *Xenorhynchium* sp., a gravid female mite (Acari) and a single egg of *Hadrocryptus* (Fig. 2), laid 4-5 mm from the host prepupal larva. The egg was slightly arched, 2.4 mm long with a more or less constant diameter of 0.46 mm. Upon hatching, the cryptine larva had to reach its host and probably fed externally on it. It took 21 days for the parasitoid to complete development, emerging as a male.

At opening on 22 February 2010, trap SLT-025.A1 contained seven cells with four prepupal larvae of *Xenorhynchium* sp. (Vespidae: Eumeninae) in cells 2, 4, 5 and 7 and three cocoons of *Hadrocryptus* in cells 1, 3 and 6 (Fig. 3). The desiccated integuments of the host larvae were also found in the parasitised cells. All three parasitoids were females. The first author witnessed the emergence of *Hadrocryptus perforator* from cell 1 and it took approximately three minutes for the cryptine to breach its cocoon (Fig. 5); the individual in cell 3 followed minutes afterwards.

Trap SLT-025.A4 contained six cells with five pre-pupal larvae of *Xenorhynchium* sp. and one cocoon of *Hadrocryptus* (Fig. 4) in cell 4 which also contained the desiccated integument of the host larva. The single individual emerged as a female on 20 March 2010 when the first author inspected the trap content. The cryptine took approximately five minutes to breach the cocoon.

Trap PSO-093.A3 contained three cells fabricated by *Isodontia diodon* (Sphecidae: Sphecinae), a single male parasitoid emerged. Trap PSO-117.A2 contained two cells of *Xenorhynchium* sp., of which one was parasitised by *Hadrocryptus perforator*. Emergence of the parasitoid has not been witnessed at drafting of this paper. Trap PSO-117. A6 contained five cells of *Zethus* sp. (Vespidae: Eumeninae), of which two were parasitised. At opening there were five prepupal larvae of the host and two small larvae of the parasitoid in cell 1 and cell 3 (Fig. 7). Both emerged as males.

In all cases the parasitoid pupae were positioned head towards the trap entrance. By 14 March 2010, the *Hadrocryptus* pupae showed clear colour markings through the cocoon in both SLT-025.A1 and A4 traps (Fig. 6).

Four out of six parasitised nests were of *Xenorhynchium* sp., although a different eumenine was also host to the parasitoid and more surprisingly a sphecid. Data are too limited to say whether there is any taxonomic host preference. With development as an

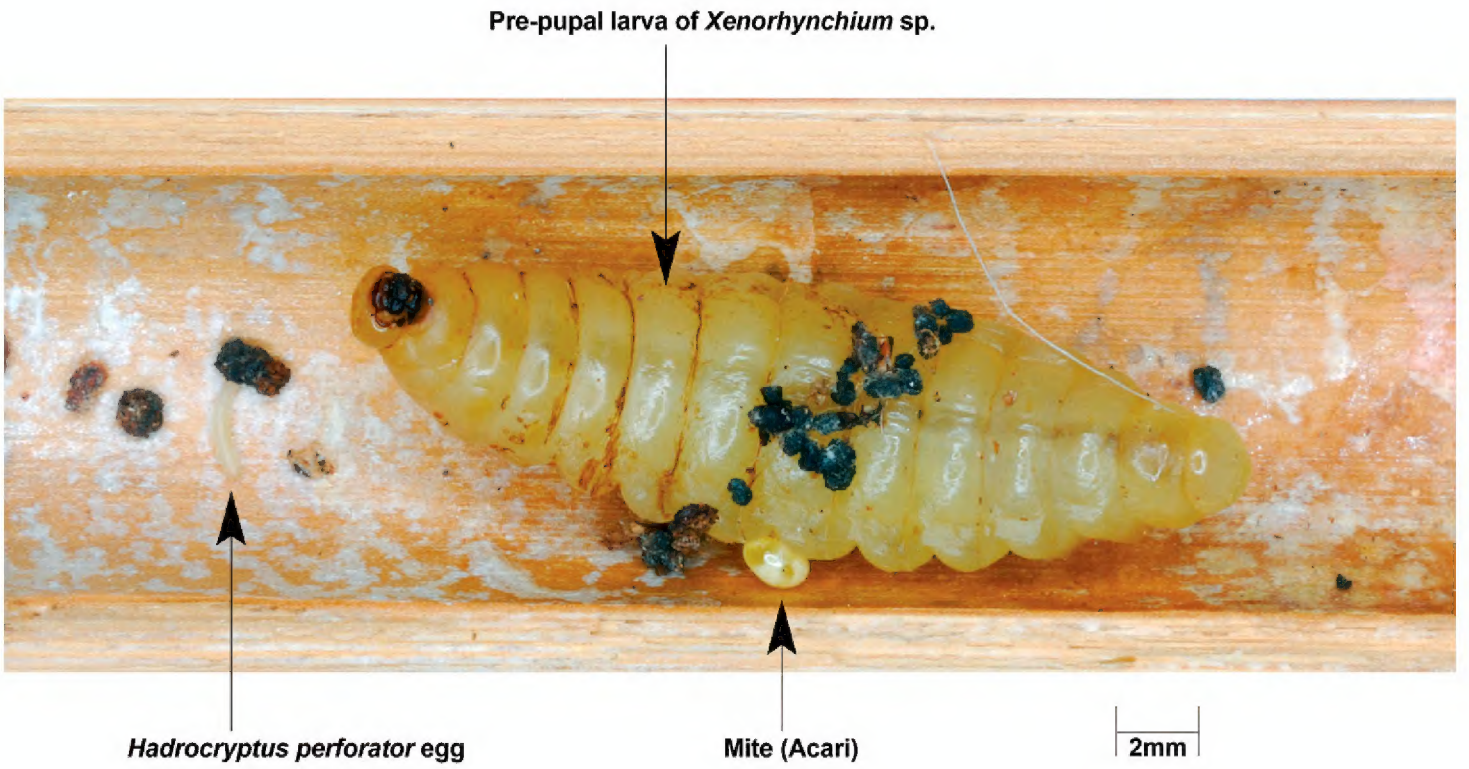

Figure 2. Trap NTC-028.A4 at opening.

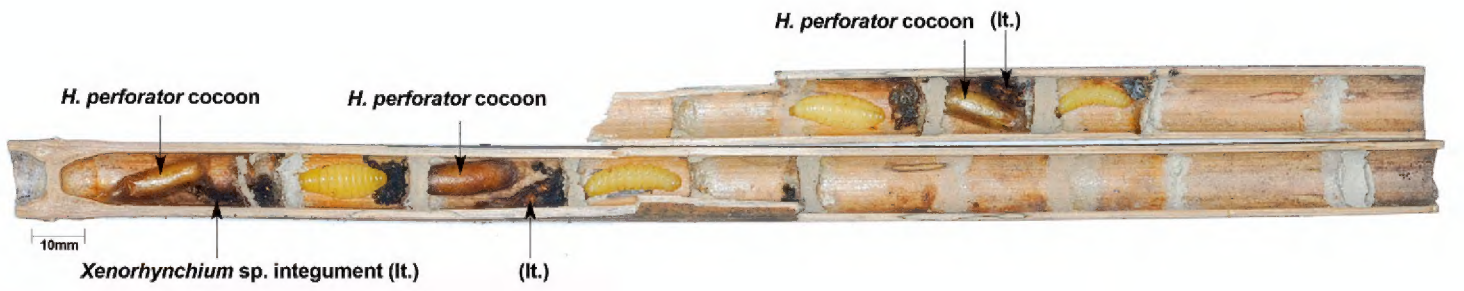

Figure 3. Trap SLT.025.A1 at opening.

Figure 4. Trap SLT.025.A4 at opening.

Figure 5. The emergence sequence of an adult *Hadrocryptus perforator* from trap SLT-025.A4.

Table 2. Contents of each trap.

Trap reference	Host sub-family	Host species	No. of host cells	No. of cells parasitized	Parasitoid emergence date	Males	Females
SLT.025.A1	Eumeninae	*Xenorhynchium* sp.	7	3	20-Mar-2010 & 22- Mar-2010		3
SLT.025.A4	Eumeninae	*Xenorhynchium* sp.	6	1	20-Mar-10		1
NTC.028.A4	Eumeninae	*Xenorhynchium* sp.	1	1	01-Aug-09	1	
PSO-093.A3	Sphecinae	*Isodontia diodon*	3	1	13-Jun-10	1	
PSO-117.A2	Eumeninae	*Xenorhynchium* sp.	2	1	?	?	?
PSO-117.A6	Eumeninae	*Zethus* sp.	5	2	3-Apr-2011 & 04- Apr-2011	2	
		Totals	**24**	**9**		**4**	**4**

Figure 6. Cell 4 of trap SLT-025.A4 showing the coloration of the pupa inside the cocoon.

idiobiont ectoparasitoid, it is probable that a variety of aculeate Hymenoptera in stem nests will be suitable as hosts.

The parasitoid's cocoons were 15.7-18.4 mm long (mean = 17.6 mm; n = 5) and 4.1-6.4 mm in diameter (mean = 5.3; n = 5). They were composed of a thin single layer of finely spun silk (0.06 mm thick; measured with a precision s/s calliper), shiny and brownish in colour yet translucent, affixed to the cell walls with numerous silk strands (Fig. 6). The meconium was discharged by the pupating larva internally at the anal end of the cocoon along with the shed integument.

There was no apparent spatial determinism in the location of the parasitised cells. Additionally, both male and female eumenine wasps emerged from the two SLT traps, so there was no apparent host sexual preference by the parasitoid.

Xenorhynchium sp. fashions cell partitions out of fine clay/soil with inclusion of sand grains, approximately 2-3 mm thick; however, *Hadrocryptus perforator* managed to per-

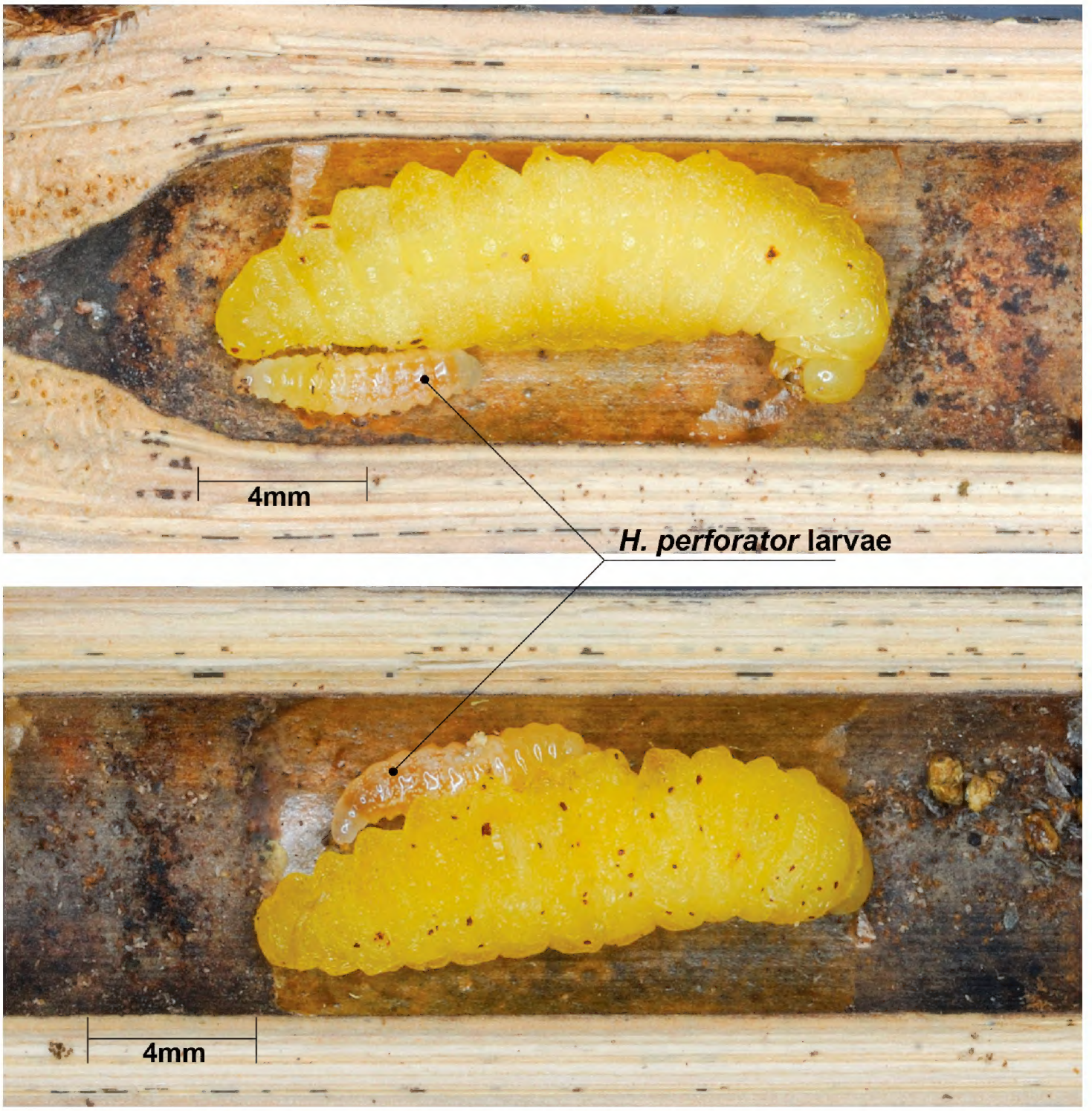

Figure 7. Larva of *Hadrocryptus perforator* feeding on prepupal larva of *Zethus* sp., trap PSO-117.A.6.

forate this obstacle without any apparent difficulty, creating an opening approximately 4 mm in diameter. Although *Zethus* sp. constructs thin cell partitions probably composed of glandular secretions, the first parasitoid to emerge from trap PSO-117.A6 did so by chewing its way through the trap walls (bamboo), rather than through the cell partitions.

As evidenced by trap NTC-028.A4 and PSO-117.A6, *Hadrocryptus* lays its egg well after the nest has been closed and sealed by the host. It does so by ovipositing through the trap walls (bamboo) and not by physically entering the nest, as shown by the intact partitions at tube opening. From the very limited data (tube SLT-025.A1 only) it seems that the parasitoid located in the outermost cell emerges first.

There was a 1:1 female to male ratio (n = 8) in the reared specimens.

The emergence of *Hadrocryptus perforator* was from March to August and its development time is approximately three weeks, therefore it can be inferred that this cryptine

Figure 8. Habitus of female *Hadrocryptus perforator*.

is multivoltine in Hong Kong, with the last generation overwintering as prepupal larvae or pupae. In fact the voltinism of this species might coincide with that of its hosts.

Conclusion

Although most host records of gabuniines are from wood-boring Coleoptera, reliable host records are in short supply and parasitism of stem-nesting aculeates may have evolved more frequently, as has been the case in Pimplinae (Gauld et al. 2002). The limited observations presented here are relevant as nothing was previously known about the biology of this genus. Further nest trapping of Aculeata may answer critical questions such as development time, voltinism and sex ratio, and particularly the mechanisms at play in host selection.

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